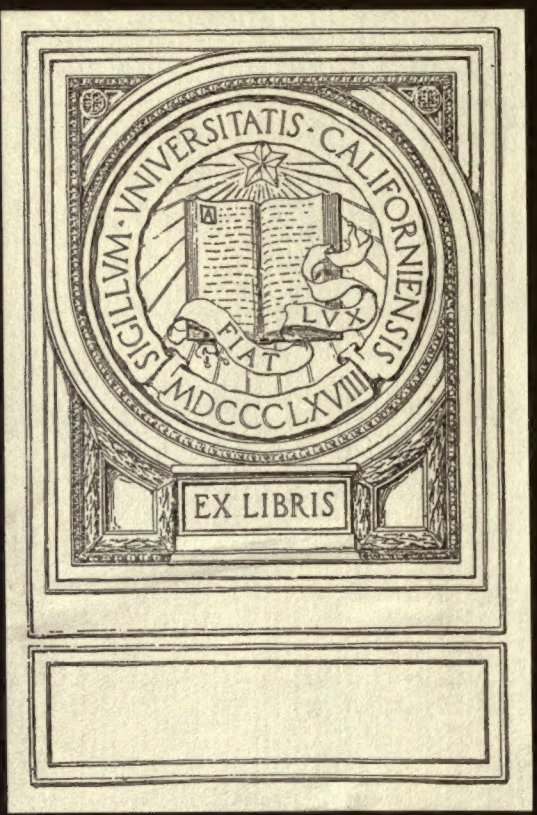
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Letter of the chief engineer, together with estimates on gagings made Jan. 15-18,1913 on Alameda Creek at Sunol Dam.

F.C.Hermann, chief engineer

SPRING VALLEY WATER COMPANY
375 SUTTER STREET
CALIFORNIA

ENGINEERING DEPARTMENT
F. C. HERRMANN
CHIEF ENGINEER

96

SAN FRANCISCO, CAL. February 4, 1913.

S. P. Eastman, Esq.,
Vice President and Manager,
Spring Valley Water Company.

Dear Sir:-

For the last 23 years the flow of Alameda Creek has been measured at Niles and Sunol dams, the latter being used since 1900. The method of measurement was to carefully record the height of water over the crests of the dams, and compute the flow by means of the standard Francis weir formula, making no allowance for the increase due to velocity of approach, nor for the decrease due to submergence at very high heads.

Last year new discharge curves for the flow over these dams were made from very careful and scientific experiments by Prof. J. N. LeConte on models of these weirs. Prof. LeConte's results were used in computing the discharge of the Alameda Creek in my "Report on the Safe Dependable Yield and Availability of the Resources of the Spring Valley Water Company," which was incorporated in the Spring Valley Water Company's Report on "The Future Water Supply of San Francisco from the Conservation and Use of its Present Resources", to the Honorable Secretary of the Interior and the Advisory Board of Engineers of the United States Army.

In order to check the determinations of Prof. LeConte, preparations were made this year to measure the flow of Alameda Creek

at Sunol dam by current meter gagings. Alameda Creek approaches the Sunol dam in a very straight and uniform channel for a distance of over 2,000 feet,- a channel which Mr. Freeman describes as an "excellent straight approach."

In this channel, about 200 feet upstream from the Sunol dam, a gaging station was established by constructing a permanent suspension foot bridge and making a careful survey of the channel cross-section. The lip of the dam was reconstructed to conform identically with former conditions, and connected by a careful set of level measurements with the gages and points of previous measurements. A gage was also established at the gaging station. In addition to these, two automatic recorders of the latest Gurley type were installed to record the height of water both above and below the dam. The recorders record every fifteen minutes the height of the water surface to the nearest one hundredth of a foot, on both the upstream and the downstream sides of the dam, thus determining both the depth of flow over the dam and the degree of submergence.

Diagram #1 shows the relative position of the Alameda Creek Channel, the Sunol dam, the gaging station, three gages and the automatic recorders.

The first flood waters this season passed over the dam from January 15th to January 18th, 1913. During this flood careful current meter measurements were made to determine the flow of Alameda Creek corresponding to depths over the crest of the dam of 1.00 feet, 1.05 feet, 1.68 feet and 1.94 feet. The depths were measured on gages in exactly the same positions used during the 12 years the Sunol dam was

at Smoot dam by current meter gagings. Alameda Creek approaches the tunnel dam in a very straight and uniform channel for a distance of over 2,000 feet,- a channel which Mr. Freeman describes as an "excellent straight approach."

In this channel, about 300 feet upstream from the tunnel dam, a gaging station was established by constructing a permanent suspension foot bridge and making a careful survey of the channel cross-section. The lip of the dam was reconstructed to conform identically with former conditions, and connected by a careful net of level measurements with the gages and points of previous measurements. A gage was also established at the gaging station. In addition to these, two automatic recorders of the Ystest Gurley type were installed to record the height of water both above and below the dam. The recorders record every fifteen minutes the height of the water surface to the nearest one hundredth of a foot, on both the upstream and the downstream side of the dam, thus determining both the depth of flow over the dam and the degree of submergence.

Diagram #1 shows the relative position of the Alameda Creek Channel, the tunnel dam, the gaging station, three gages and the automatic recorders.

The first flood waters this season passed over the dam from January 15th to January 16th, 1918. During this flood careful current meter measurements were made to determine the flow of Alameda Creek corresponding to depths over the crest of the dam of 1.00 foot, 1.02 feet, 1.05 feet and 1.08 feet. The depths were measured on gages in exactly the same positions used during the 12 years the tunnel dam was

used as a point of measurement.

Velocities of the water were measured with a standard Price current meter recently rated by Mr. E. J. Koff, of the U. S. Irrigation Investigation, at the rating station at the University of California, Berkeley. The channel was divided transversely into ten foot sections. In each section the velocity was observed at six tenths depth from the water surface, this being taken as in all standard current meter work, as the average velocity for the section. These average velocities were repeatedly checked by the integration method, three or four round trips being slowly made by the current meter between the surface of the water and the bottom of the channel. Fortunately, it was possible to make the gaging with no wind blowing, and in each instance exceedingly close checks resulted in the two methods of measurements.

For night work large locomotive headlights were used to illuminate the gaging station, making the work at night as reliable as that done in daylight.

Appended hereto are the details of the current meter measurements, the equation of the current meter determined by Mr. Koff being $V = 2.254\ R + .065$.

The results of these gagings are as follows:-

used as a point of measurement.

Velocities of the water were measured with a standard Price current meter recently rated by Mr. E. J. Hoff, of the U. S. Irrigation Investigation, at the testing station at the University of California, Berkeley.

The channel was divided transversely into ten foot sections. In each section the velocity was observed at six tenths depth from the water surface, this being taken as in all standard current meter work, as the average velocity for the section. These average velocities were repeatedly checked by the integration method, three or four round trips being closely made by the current meter between the surface of the water and the bottom of the channel. Fortunately, it was possible to make the reading with no wind blowing, and in each instance exceedingly close checks resulted in the two methods of measurement.

For night work large locomotive headlights were used to illuminate the reading station, making the work at night as reliable as that done in daylight.

Expressed herein are the details of the current meter measurements, the equation of the current meter determined by Mr. Hoff being V = 2.384 R + .022.

The results of these gagings are as follows:-

ALAMEDA CREEK DISCHARGE AT SUNOL DAM

Date 1913	Hour	Gage Height: Gaging Station Feet	Gage Height: Sunol Dam Feet	Depth over Dam Feet	Discharge: Measured by Current Meter M.G.D.	Velocity of Approach Measured at Gaging Station Feet per Sec.
Jan. 15	12 P.M.	1.70	1.65	1.05	364	1.30
16	3 P.M.	1.65	1.60	1.00	329	1.15
16	8:30 P.M.	2.38	2.20	1.68	735	2.26
18	3 P.M.	2.63	2.38	1.94	937	2.73

The following is a comparison of the actual gagings with the discharge for equal depths over the Sunol dam, as determined from Prof. LeConte's curve:-

Date 1913	Depth over Dam Feet	Discharge: Measured M.G.D.	Discharge: LeConte M.G.D.	Increased Flow in M. G. D. by Actual Measurement M.G.D.	Per cent. Increased Flow
Jan. 16	1.00	329	293	36	12.3%
15	1.05	364	317	47	14.8%
16	1.68	735	635	100	15.7%
18	1.94	937	797	140	17.6%
				Average -	15.1%

This table shows that the actual measurements within the range of these determinations are consistently higher (from 12.3% to 17.6%) than those obtained from the LeConte curve.

On diagram #3 are graphically shown the discharge curve of Sunol dam, as per the LeConte experiments, between the gage height limits

Alarms Clocks Imported at Ellis Isl

Year ended June 30	Clocks Value	Clocks Duty	Watches Value	Watches Duty
1913	$	$	$	$
14	1,000	400	2,000	800
15	1,200	480	2,400	960
16	1,500	600	3,000	1,200
17	1,800	720	3,600	1,440
18	2,000	800	4,000	1,600
19	2,200	880	4,400	1,760
20	2,500	1,000	5,000	2,000
21	2,800	1,120	5,600	2,240
22	3,000	1,200	6,000	2,400
23	3,200	1,280	6,400	2,560
24	3,500	1,400	7,000	2,800
25	3,800	1,520	7,600	3,040
26	4,000	1,600	8,000	3,200
27	4,200	1,680	8,400	3,360
28	4,500	1,800	9,000	3,600
29	4,800	1,920	9,600	3,840
30	5,000	2,000	10,000	4,000
31	5,200	2,080	10,400	4,160
32	5,500	2,200	11,000	4,400
33	5,800	2,320	11,600	4,640
34	6,000	2,400	12,000	4,800
35	6,200	2,480	12,400	4,960
36	6,500	2,600	13,000	5,200
37	6,800	2,720	13,600	5,440
38	7,000	2,800	14,000	5,600
39	7,200	2,880	14,400	5,760
40	7,500	3,000	15,000	6,000
41	7,800	3,120	15,600	6,240
42	8,000	3,200	16,000	6,400
43	8,200	3,280	16,400	6,560
44	8,500	3,400	17,000	6,800
45	8,800	3,520	17,600	7,040
46	9,000	3,600	18,000	7,200
47	9,200	3,680	18,400	7,360
48	9,500	3,800	19,000	7,600
49	9,800	3,920	19,600	7,840
50	10,000	4,000	20,000	8,000
51	10,200	4,080	20,400	8,160
52	10,500	4,200	21,000	8,400
53	10,800	4,320	21,600	8,640
54	11,000	4,400	22,000	8,800
55	11,200	4,480	22,400	8,960
56	11,500	4,600	23,000	9,200
57	11,800	4,720	23,600	9,440
58	12,000	4,800	24,000	9,600
59	12,200	4,880	24,400	9,760
60	12,500	5,000	25,000	10,000
61	12,800	5,120	25,600	10,240
62	13,000	5,200	26,000	10,400
63	13,200	5,280	26,400	10,560
64	13,500	5,400	27,000	10,800
65	13,800	5,520	27,600	11,040
66	14,000	5,600	28,000	11,200
67	14,200	5,680	28,400	11,360
68	14,500	5,800	29,000	11,600
69	14,800	5,920	29,600	11,840
70	15,000	6,000	30,000	12,000
71	15,200	6,080	30,400	12,160
72	15,500	6,200	31,000	12,400
73	15,800	6,320	31,600	12,640
74	16,000	6,400	32,000	12,800
75	16,200	6,480	32,400	12,960
76	16,500	6,600	33,000	13,200
77	16,800	6,720	33,600	13,440
78	17,000	6,800	34,000	13,600
79	17,200	6,880	34,400	13,760
80	17,500	7,000	35,000	14,000
81	17,800	7,120	35,600	14,240
82	18,000	7,200	36,000	14,400
83	18,200	7,280	36,400	14,560
84	18,500	7,400	37,000	14,800
85	18,800	7,520	37,600	15,040
86	19,000	7,600	38,000	15,200
87	19,200	7,680	38,400	15,360
88	19,500	7,800	39,000	15,600
89	19,800	7,920	39,600	15,840
90	20,000	8,000	40,000	16,000
91	20,200	8,080	40,400	16,160
92	20,500	8,200	41,000	16,400
93	20,800	8,320	41,600	16,640
94	21,000	8,400	42,000	16,800
95	21,200	8,480	42,400	16,960
96	21,500	8,600	43,000	17,200
97	21,800	8,720	43,600	17,440
98	22,000	8,800	44,000	17,600
99	22,200	8,880	44,400	17,760
1900	22,500	9,000	45,000	18,000
01	22,800	9,120	45,600	18,240
02	23,000	9,200	46,000	18,400
03	23,200	9,280	46,400	18,560
04	23,500	9,400	47,000	18,800
05	23,800	9,520	47,600	19,040
06	24,000	9,600	48,000	19,200
07	24,200	9,680	48,400	19,360
08	24,500	9,800	49,000	19,600
09	24,800	9,920	49,600	19,840
10	25,000	10,000	50,000	20,000
11	25,200	10,080	50,400	20,160
12	25,500	10,200	51,000	20,400
13	25,800	10,320	51,600	20,640
14	26,000	10,400	52,000	20,800
15	26,200	10,480	52,400	20,960
16	26,500	10,600	53,000	21,200
17	26,800	10,720	53,600	21,440
18	27,000	10,800	54,000	21,600
19	27,200	10,880	54,400	21,760
20	27,500	11,000	55,000	22,000
21	27,800	11,120	55,600	22,240
22	28,000	11,200	56,000	22,400
23	28,200	11,280	56,400	22,560
24	28,500	11,400	57,000	22,800
25	28,800	11,520	57,600	23,040
26	29,000	11,600	58,000	23,200
27	29,200	11,680	58,400	23,360
28	29,500	11,800	59,000	23,600
29	29,800	11,920	59,600	23,840
30	30,000	12,000	60,000	24,000
31	30,200	12,080	60,400	24,160
32	30,500	12,200	61,000	24,400
33	30,800	12,320	61,600	24,640
34	31,000	12,400	62,000	24,800
35	31,200	12,480	62,400	24,960
36	31,500	12,600	63,000	25,200
37	31,800	12,720	63,600	25,440
38	32,000	12,800	64,000	25,600
39	32,200	12,880	64,400	25,760
40	32,500	13,000	65,000	26,000
41	32,800	13,120	65,600	26,240
42	33,000	13,200	66,000	26,400
43	33,200	13,280	66,400	26,560
44	33,500	13,400	67,000	26,800
45	33,800	13,520	67,600	27,040
46	34,000	13,600	68,000	27,200
47	34,200	13,680	68,400	27,360
48	34,500	13,800	69,000	27,600
49	34,800	13,920	69,600	27,840
50	35,000	14,000	70,000	28,000
51	35,200	14,080	70,400	28,160
52	35,500	14,200	71,000	28,400
53	35,800	14,320	71,600	28,640
54	36,000	14,400	72,000	28,800
55	36,200	14,480	72,400	28,960
56	36,500	14,600	73,000	29,200
57	36,800	14,720	73,600	29,440
58	37,000	14,800	74,000	29,600
59	37,200	14,880	74,400	29,760
60	37,500	15,000	75,000	30,000
61	37,800	15,120	75,600	30,240
62	38,000	15,200	76,000	30,400
63	38,200	15,280	76,400	30,560
64	38,500	15,400	77,000	30,800
65	38,800	15,520	77,600	31,040
66	39,000	15,600	78,000	31,200
67	39,200	15,680	78,400	31,360
68	39,500	15,800	79,000	31,600
69	39,800	15,920	79,600	31,840
70	40,000	16,000	80,000	32,000
71	40,200	16,080	80,400	32,160
72	40,500	16,200	81,000	32,400
73	40,800	16,320	81,600	32,640
74	41,000	16,400	82,000	32,800
75	41,200	16,480	82,400	32,960
76	41,500	16,600	83,000	33,200
77	41,800	16,720	83,600	33,440
78	42,000	16,800	84,000	33,600
79	42,200	16,880	84,400	33,760
80	42,500	17,000	85,000	34,000
81	42,800	17,120	85,600	34,240
82	43,000	17,200	86,000	34,400
83	43,200	17,280	86,400	34,560
84	43,500	17,400	87,000	34,800
85	43,800	17,520	87,600	35,040
86	44,000	17,600	88,000	35,200
87	44,200	17,680	88,400	35,360
88	44,500	17,800	89,000	35,600
89	44,800	17,920	89,600	35,840
90	45,000	18,000	90,000	36,000
91	45,200	18,080	90,400	36,160
92	45,500	18,200	91,000	36,400
93	45,800	18,320	91,600	36,640
94	46,000	18,400	92,000	36,800
95	46,200	18,480	92,400	36,960
96	46,500	18,600	93,000	37,200
97	46,800	18,720	93,600	37,440
98	47,000	18,800	94,000	37,600
99	47,200	18,880	94,400	37,760
1900	47,500	19,000	95,000	38,000
01	47,800	19,120	95,600	38,240
02	48,000	19,200	96,000	38,400
03	48,200	19,280	96,400	38,560
04	48,500	19,400	97,000	38,800
05	48,800	19,520	97,600	39,040
06	49,000	19,600	98,000	39,200
07	49,200	19,680	98,400	39,360
08	49,500	19,800	99,000	39,600
09	49,800	19,920	99,600	39,840
10	50,000	20,000	100,000	40,000
11	50,200	20,080	100,400	40,160
12	50,500	20,200	101,000	40,400
13	50,800	20,320	101,600	40,640
14	51,000	20,400	102,000	40,800
15	51,200	20,480	102,400	40,960
16	51,500	20,600	103,000	41,200
17	51,800	20,720	103,600	41,440
18	52,000	20,800	104,000	41,600
19	52,200	20,880	104,400	41,760
20	52,500	21,000	105,000	42,000
21	52,800	21,120	105,600	42,240
22	53,000	21,200	106,000	42,400
23	53,200	21,280	106,400	42,560
24	53,500	21,400	107,000	42,800
25	53,800	21,520	107,600	43,040
26	54,000	21,600	108,000	43,200
27	54,200	21,680	108,400	43,360
28	54,500	21,800	109,000	43,600
29	54,800	21,920	109,600	43,840
30	55,000	22,000	110,000	44,000
31	55,200	22,080	110,400	44,160
32	55,500	22,200	111,000	44,400
33	55,800	22,320	111,600	44,640
34	56,000	22,400	112,000	44,800
35	56,200	22,480	112,400	44,960
36	56,500	22,600	113,000	45,200
37	56,800	22,720	113,600	45,440
38	57,000	22,800	114,000	45,600
39	57,200	22,880	114,400	45,760
40	57,500	23,000	115,000	46,000
41	57,800	23,120	115,600	46,240
42	58,000	23,200	116,000	46,400
43	58,200	23,280	116,400	46,560
44	58,500	23,400	117,000	46,800
45	58,800	23,520	117,600	47,040
46	59,000	23,600	118,000	47,200
47	59,200	23,680	118,400	47,360
48	59,500	23,800	119,000	47,600
49	59,800	23,920	119,600	47,840
50	60,000	24,000	120,000	48,000
51	60,200	24,080	120,400	48,160
52	60,500	24,200	121,000	48,400
53	60,800	24,320	121,600	48,640
54	61,000	24,400	122,000	48,800
55	61,200	24,480	122,400	48,960
56	61,500	24,600	123,000	49,200
57	61,800	24,720	123,600	49,440
58	62,000	24,800	124,000	49,600
59	62,200	24,880	124,400	49,760
60	62,500	25,000	125,000	50,000
61	62,800	25,120	125,600	50,240
62	63,000	25,200	126,000	50,400
63	63,200	25,280	126,400	50,560
64	63,500	25,400	127,000	50,800
65	63,800	25,520	127,600	51,040
66	64,000	25,600	128,000	51,200
67	64,200	25,680	128,400	51,360
68	64,500	25,800	129,000	51,600
69	64,800	25,920	129,600	51,840
70	65,000	26,000	130,000	52,000
71	65,200	26,080	130,400	52,160
72	65,500	26,200	131,000	52,400
73	65,800	26,320	131,600	52,640
74	66,000	26,400	132,000	52,800
75	66,200	26,480	132,400	52,960
76	66,500	26,600	133,000	53,200
77	66,800	26,720	133,600	53,440
78	67,000	26,800	134,000	53,600
79	67,200	26,880	134,400	53,760
80	67,500	27,000	135,000	54,000
81	67,800	27,120	135,600	54,240
82	68,000	27,200	136,000	54,400
83	68,200	27,280	136,400	54,560
84	68,500	27,400	137,000	54,800
85	68,800	27,520	137,600	55,040
86	69,000	27,600	138,000	55,200
87	69,200	27,680	138,400	55,360
88	69,500	27,800	139,000	55,600
89	69,800	27,920	139,600	55,840
90	70,000	28,000	140,000	56,000
91	70,200	28,080	140,400	56,160
92	70,500	28,200	141,000	56,400
93	70,800	28,320	141,600	56,640
94	71,000	28,400	142,000	56,800
95	71,200	28,480	142,400	56,960
96	71,500	28,600	143,000	57,200
97	71,800	28,720	143,600	57,440
98	72,000	28,800	144,000	57,600
99	72,200	28,880	144,400	57,760
1900	72,500	29,000	145,000	58,000
01	72,800	29,120	145,600	58,240
02	73,000	29,200	146,000	58,400
03	73,200	29,280	146,400	58,560
04	73,500	29,400	147,000	58,800
05	73,800	29,520	147,600	59,040
06	74,000	29,600	148,000	59,200
07	74,200	29,680	148,400	59,360
08	74,500	29,800	149,000	59,600
09	74,800	29,920	149,600	59,840
10	75,000	30,000	150,000	60,000
11	75,200	30,080	150,400	60,160
12	75,500	30,200	151,000	60,400
13	75,800	30,320	151,600	60,640
14	76,000	30,400	152,000	60,800
15	76,200	30,480	152,400	60,960
16	76,500	30,600	153,000	61,200
17	76,800	30,720	153,600	61,440
18	77,000	30,800	154,000	61,600
19	77,200	30,880	154,400	61,760
20	77,500	31,000	155,000	62,000
21	77,800	31,120	155,600	62,240
22	78,000	31,200	156,000	62,400
23	78,200	31,280	156,400	62,560
24	78,500	31,400	157,000	62,800
25	78,800	31,520	157,600	63,040
26	79,000	31,600	158,000	63,200
27	79,200	31,680	158,400	63,360
28	79,500	31,800	159,000	63,600
29	79,800	31,920	159,600	63,840
30	80,000	32,000	160,000	64,000
31	80,200	32,080	160,400	64,160
32	80,500	32,200	161,000	64,400
33	80,800	32,320	161,600	64,640
34	81,000	32,400	162,000	64,800
35	81,200	32,480	162,400	64,960
36	81,500	32,600	163,000	65,200
37	81,800	32,720	163,600	65,440
38	82,000	32,800	164,000	65,600
39	82,200	32,880	164,400	65,760
40	82,500	33,000	165,000	66,000
41	82,800	33,120	165,600	66,240
42	83,000	33,200	166,000	66,400
43	83,200	33,280	166,400	66,560
44	83,500	33,400	167,000	66,800
45	83,800	33,520	167,600	67,040
46	84,000	33,600	168,000	67,200
47	84,200	33,680	168,400	67,360
48	84,500	33,800	169,000	67,600
49	84,800	33,920	169,600	67,840
50	85,000	34,000	170,000	68,000
51	85,200	34,080	170,400	68,160
52	85,500	34,200	171,000	68,400
53	85,800	34,320	171,600	68,640
54	86,000	34,400	172,000	68,800
55	86,200	34,480	172,400	68,960
56	86,500	34,600	173,000	69,200
57	86,800	34,720	173,600	69,440
58	87,000	34,800	174,000	69,600
59	87,200	34,880	174,400	69,760
60	87,500	35,000	175,000	70,000
61	87,800	35,120	175,600	70,240
62	88,000	35,200	176,000	70,400
63	88,200	35,280	176,400	70,560
64	88,500	35,400	177,000	70,800
65	88,800	35,520	177,600	71,040
66	89,000	35,600	178,000	71,200
67	89,200	35,680	178,400	71,360
68	89,500	35,800	179,000	71,600
69	89,800	35,920	179,600	71,840
70	90,000	36,000	180,000	72,000
71	90,200	36,080	180,400	72,160
72	90,500	36,200	181,000	72,400
73	90,800	36,320	181,600	72,640
74	91,000	36,400	182,000	72,800
75	91,200	36,480	182,400	72,960
76	91,500	36,600	183,000	73,200
77	91,800	36,720	183,600	73,440
78	92,000	36,800	184,000	73,600
79	92,200	36,880	184,400	73,760
80	92,500	37,000	185,000	74,000
81	92,800	37,120	185,600	74,240
82	93,000	37,200	186,000	74,400
83	93,200	37,280	186,400	74,560
84	93,500	37,400	187,000	74,800
85	93,800	37,520	187,600	75,040
86	94,000	37,600	188,000	75,200
87	94,200	37,680	188,400	75,360
88	94,500	37,800	189,000	75,600
89	94,800	37,920	189,600	75,840
90	95,000	38,000	190,000	76,000
91	95,200	38,080	190,400	76,160
92	95,500	38,200	191,000	76,400
93	95,800	38,320	191,600	76,640
94	96,000	38,400	192,000	76,800
95	96,200	38,480	192,400	76,960
96	96,500	38,600	193,000	77,200
97	96,800	38,720	193,600	77,440
98	97,000	38,800	194,000	77,600
99	97,200	38,880	194,400	77,760
1900	97,500	39,000	195,000	78,000
01	97,800	39,120	195,600	78,240
02	98,000	39,200	196,000	78,400
03	98,200	39,280	196,400	78,560
04	98,500	39,400	197,000	78,800
05	98,800	39,520	197,600	79,040
06	99,000	39,600	198,000	79,200
07	99,200	39,680	198,400	79,360
08	99,500	39,800	199,000	79,600
09	99,800	39,920	199,600	79,840
10	100,000	40,000	200,000	80,000
11	100,200	40,080	200,400	80,160
12	100,500	40,200	201,000	80,400
13	100,800	40,320	201,600	80,640
14	101,000	40,400	202,000	80,800
15	101,200	40,480	202,400	80,960
16	101,500	40,600	203,000	81,200
17	101,800	40,720	203,600	81,440
18	102,000	40,800	204,000	81,600
19	102,200	40,880	204,400	81,760
20	102,500	41,000	205,000	82,000
21	102,800	41,120	205,600	82,240
22	103,000	41,200	206,000	82,400
23	103,200	41,280	206,400	82,560
24	103,500	41,400	207,000	82,800
25	103,800	41,520	207,600	83,040
26	104,000	41,600	208,000	83,200
27	104,200	41,680	208,400	83,360
28	104,500	41,800	209,000	83,600
29	104,800	41,920	209,600	83,840
30	105,000	42,000	210,000	84,000
31	105,200	42,080	210,400	84,160
32	105,500	42,200	211,000	84,400
33	105,800	42,320	211,600	84,640
34	106,000	42,400	212,000	84,800
35	106,200	42,480	212,400	84,960
36	106,500	42,600	213,000	85,200
37	106,800	42,720	213,600	85,440
38	107,000	42,800	214,000	85,600
39	107,200	42,880	214,400	85,760
40	107,500	43,000	215,000	86,000
41	107,800	43,120	215,600	86,240
42	108,000	43,200	216,000	86,400
43	108,200	43,280	216,400	86,560
44	108,500	43,400	217,000	86,800
45	108,800	43,520	217,600	87,040
46	109,000	43,600	218,000	87,200
47	109,200	43,680	218,400	87,360
48	109,500	43,800	219,000	87,600
49	109,800	43,920	219,600	87,840
50	110,000	44,000	220,000	88,000
51	110,200	44,080	220,400	88,160
52	110,500	44,200	221,000	88,400
53	110,800	44,320	221,600	88,640
54	111,000	44,400	222,000	88,800
55	111,200	44,480	222,400	88,960
56	111,500	44,600	223,000	89,200
57	111,800	44,720	223,600	89,440
58	112,000	44,800	224,000	89,600
59	112,200	44,880	224,400	89,760
60	112,500	45,000	225,000	90,000
61	112,800	45,120	225,600	90,240
62	113,000	45,200	226,000	90,400
63	113,200	45,280	226,400	90,560
64	113,500	45,400	227,000	90,800
65	113,800	45,520	227,600	91,040
66	114,000	45,600	228,000	91,200
67	114,200	45,680	228,400	91,360
68	114,500	45,800	229,000	91,600
69	114,800	45,920	229,600	91,840
70	115,000	46,000	230,000	92,000
71	115,200	46,080	230,400	92,160
72	115,500	46,200	231,000	92,400
73	115,800	46,320	231,600	92,640
74	116,000	46,400	232,000	92,800
75	116,200	46,480	232,400	92,960
76	116,500	46,600	233,000	93,200
77	116,800	46,720	233,600	93,440
78	117,000	46,800	234,000	93,600
79	117,200	46,880	234,400	93,760
80	117,500	47,000	235,000	94,000
81	117,800	47,120	235,600	94,240
82	118,000	47,200	236,000	94,400
83	118,200	47,280	236,400	94,560
84	118,500	47,400	237,000	94,800
85	118,800	47,520	237,600	95,040
86	119,000	47,600	238,000	95,200
87	119,200	47,680	238,400	95,360
88	119,500	47,800	239,000	95,600
89	119,800	47,920	239,600	95,840
90	120,000	48,000	240,000	96,000
91	120,200	48,080	240,400	96,160
92	120,500	48,200	241,000	96,400
93	120,800	48,320	241,600	96,640
94	121,000	48,400	242,000	96,800
95	121,200	48,480	242,400	96,960
96	121,500	48,600	243,000	97,200
97	121,800	48,720	243,600	97,440
98	122,000	48,800	244,000	97,600
99	122,200	48,880	244,400	97,760
1900	122,500	49,000	245,000	98,000
01	122,800	49,120	245,600	98,240
02	123,000	49,200	246,000	98,400
03	123,200	49,280	246,400	98,560
04	123,500	49,400	247,000	98,800
05	123,800	49,520	247,600	99,040
06	124,000	49,600	248,000	99,200
07	124,200	49,680	248,400	99,360
08	124,500	49,800	249,000	99,600
09	124,800	49,920	249,600	99,840
10	125,000	50,000	250,000	100,000
11	125,200	50,080	250,400	100,160
12	125,500	50,200	251,000	100,400
13	125,800	50,320	251,600	100,640
14	126,000	50,400	252,000	100,800
15	126,200	50,480	252,400	100,960
16	126,500	50,600	253,000	101,200
17	126,800	50,720	253,600	101,440
18	127,000	50,800	254,000	101,600
19	127,200	50,880	254,400	101,760
20	127,500	51,000	255,000	102,000
21	127,800	51,120	255,600	102,240
22	128,000	51,200	256,000	102,400
23	128,200	51,280	256,400	102,560
24	128,500	51,400	257,000	102,800
25	128,800	51,520	257,600	103,040
26	129,000	51,600	258,000	103,200
27	129,200	51,680	258,400	103,360
28	129,500	51,800	259,000	103,600
29	129,800	51,920	259,600	103,840
30	130,000	52,000	260,000	104,000
31	130,200	52,080	260,400	104,160
32	130,500	52,200	261,000	104,400
33	130,800	52,320	261,600	104,640
34	131,000	52,400	262,000	104,800
35	131,200	52,480	262,400	104,960
36	131,500	52,600	263,000	105,200
37	131,800	52,720	263,600	105,440
38	132,000	52,800	264,000	105,600
39	132,200	52,880	264,400	105,760
40	132,500	53,000	265,000	106,000
41	132,800	53,120	265,600	106,240
42	133,000	53,200	266,000	106,400
43	133,200	53,280	266,400	106,560
44	133,500	53,400	267,

of 0.60 feet and 2.00 feet, and the discharge curve over the same dam within the same range by actual current meter measurements. The remarkable consistency of the discharge determinations indicates the excellency of the gaging station and the reliability of the results. The parallelism of the two discharge curves (see diagram #3) indicates that for greater depths over the dam, actual measurements will give consistently greater discharges than will the LeConte curve for corresponding depths.

It is to be noted that the average stream velocity at the gaging station, which is a measure of the velocity of approach to the dam, increases almost directly with the depth over the crest of the dam. This is shown graphically in diagram #3, the velocities all falling practically on the same straight line, the ratio of increase within the range of measurements being 1.60 to 1.00. The indications are, therefore, that for such great depths over the dam as occurred in the great flood of March, 1911, the velocity of the water as it approaches the dam is much greater than the velocity induced by the fall of the water over the dam.

The greatest depth of flow over the dam during the current meter measurements was about 2 feet. Although floods of much greater depths flow over Sunol dam they occur at infrequent intervals, the great bulk of the water passing over the dam at depths not in excess of 3 feet. This is demonstrated by the following table which has been computed by using the LeConte discharge curve over Sunol dam for the period during which the flow of Alameda Creek has been measured at Sunol:

Year	Quantity of Water passed over Sunol Dam with Depth of 3 feet and less Million Gallons	Quantity of Water passed over Sunol Dam with Depth of over 3 feet Million Gallons	Total Million Gallons
1901	21,886	6,930	28,816
1902	23,291	3,405	26,696
1903	19,311	14,284	33,595
1904	30,632	0	30,632
1905	14,828	0	14,828
1906	48,412	20,459	68,871
1907	44,301	49,361	93,662
1908	12,805	0	12,805
1909	38,077	39,699	77,776
1910	23,094	0	23,094
1911	40,868	46,712	87,580
1912	4,404	0	4,404
	321,909	180,850	502,759

This table shows that for the 12 years about 64% of the total flow over Sunol dam occurred with depths of 3 feet or less. In 5 out of the 12 years, the entire flow over the dam was with depths not in excess of 3 feet, and even in the years of 1907 and 1911 with abnormal run-off the flow with depth of 3 feet or less was nearly 50% of the total.

This analysis shows that, although the greatest depth over the dam during the stream gagings was but 2 feet, the results obtained therefrom are sufficient to indicate that the run-off of Alameda Creek is materially greater than given on page 4 of the Spring Valley Water Company's

Year	Million Gallons	Million Gallons	Million Gallons
1902	12,000	6,320	22,112
1903	10,321	3,408	20,016
1904	12,112	14,284	32,208
1905	14,688	0	16,880
1906	24,880	0	14,880
1907	40,412	22,880	52,872
1908	40,208	12,321	32,208
1909	24,880	0	12,880
1910	32,077	20,040	44,776
1911	12,088	0	22,208
1912	12,880	40,712	32,320
1913	6,408	0	6,408
	321,320	120,880	208,720

Year — 2 Feet and Less — Over 2 Feet — Total

Quantity of water passed over tunnel

Percentage of water passed over tunnel with depth of 2 feet or less

Percentage of water passed over tunnel with depth of over 2 feet

This table shows that for the 12 years about 60% of the total flow over tunnel has occurred with depths of 2 feet or less. In 5 out of the 12 years, the entire flow over the dam was with depths in excess of 2 feet, and even in the years of 1907 and 1911 with abnormal run-off the flow with depth of 2 feet or less was nearly 80% of the total.

This analysis shows that, although the greatest depth over the dam during the extreme regime was but 5 feet, the trend is obviously greater than given on page 6 of the Spring Valley water development proposition to indicate that the run-off of flumes over is

Report on "The Future Water Supply of San Francisco from the Conservation and Use of its Present Resources" to the Honorable Secretary of the Interior and the Advisory Board of Engineers of the United States Army. In this report the average flow of Alameda Creek was given as 145 million gallons per day, which was computed from the discharge curve based upon the LeConte experiments. As heretofore shown, the actual stream measurements show a flow of from 12% to 17½% greater than the LeConte curve for corresponding depths over the dam. Therefore, if we apply a factor equal to the average increase of 15.1%, the average flow of Alameda Creek becomes 167 million gallons per day.

Yours very truly,

Chief Engineer.

Report on "The Income Under Supply of Gas Furnished from the Conservation and Use of its Average Resources" by the Corporate Secretary of the Interior and the Military Board of Engineers of the United States Army. To this report the average flow of Colorado River was given as 145 million gallons per day, which was computed from the Hydrograph based upon the Colorado conventions. As hereinafter shown, the natural stream measurements show a flow of less than 125 million gallons per day for twenty-consecutive days. Therefore, if we apply a factor equal to the average increase of 15.1%, the average flow of Colorado River becomes 167 million gallons per day.

Yours very truly,

Chief Engineer.

Gaging made Jan. 15, 1913, 12 P.M., by F.C.Herrmann and P.F.Jones,

on Alameda Creek, at Sunol Dam.

Gage height in ft.: beginning 1.55, end. 1.85, mean 1.70. Meter No. 6058.

Total Area 431.6 sq. ft. Mean Velocity 1.30. Discharge 562.8.

Dist. from Initial Point	Depth	Depth of observations	Time in Seconds	Revolutions	Revolutions per Second	Velocity per Second	Area	Discharge of Section	Remarks On condition of channel, wind, equipment, gage, boat, cable methods, accuracy.
111	0.0								Gage on 16 ft. bench of Sunol Dam.
113	2.0								
120	4.7		43	10	.23	.58	79.9	46.3	beg. 1.55 end. 1.75 1.65
130	6.1	Integration							
140	5.8		(18 (38	(8 (16	.43	1.05	115.5	119.0	
150	5.4								
160	5.0		24	21	.88	2.05	102.0	209.1	
170	5.0								
180	3.3		40	25	.63	1.49	73.5	109.4	
190	3.1								
200	2.9		56	31	.55	1.30	60.7	79.0	
210	2.7								
212	0.0						431.6	562.8	

Computed by T. N. Rapp.

46	19	.38	.56	79.9	46.3	
(19 (8						
(38 (11		.43	1.38	118.8	119.0	
34	21	.08	2.06	108.9	108.1	
40	25	.05	1.49	73.8	104.4	
56	21	.85	1.30	62.7	79.8	
				471.6	552.8	

Gaging made Jan. 16, 1913, beg. 3 P.M. end. 3:30 P.M., by F.C.Herrmann and P.F.Jones,

on Alameda Creek, at Sunol Dam.

Gage height in ft.: beginning 1.65, end. 1.65, mean 1.65. Meter No. 6058.

Total area 442.5 sq. ft. Mean Velocity 1.15. Discharge 509.4.

Dist. from Initial point	Depth	Depth of observations	Time in Seconds	Revolutions	Velocity per Second	Width	Mean Depth	Area	Discharge of Section	Remarks On condition of channel, wind, equipment, gage, boat, cable methods, accuracy
111	0.0									Gage at Dam 1.60
115	2.0									
120	4.6	2.7	100	32	.79			68.7	54.3	
130	6.0	3.6	100	50	1.19	10	6.0	60.	71.4	These measurements
140	5.7	3.4	100	52	1.24	10	5.7	57.	70.7	were checked by inte-
150	5.3	3.1	100	52	1.24	10	5.3	53.	65.7	gration method at
160	4.9	2.9	100	55	1.30	10	4.9	49.	63.7	Stations 130 and 170
170	4.9	2.9	100	47	1.11	10	4.9	49.	54.4	and the check was O.K.
180	3.2	1.9	100	54	1.28	10	3.2	32.	40.9	The Gurley recorder
190	3.0	1.8	100	54	1.20	10	3.0	30.	38.4	registered 5 P.M.
200	2.8	1.7	100	48	1.14			43.8	49.9	when correct time
210	2.6	1.6	100	[illegible]	[illegible]	1.90			[illegible]	was 4 P. M.
212	0.0							442.5	509.4	

Computed by F. W. Hapy.

Compiled by R. S. Bingo.

Gaging made Jan. 16, 1913, beg. 8:30 P.M. end. 9 P.M., by F.C.Herrmann and F.F.Jones,

on Alameda Creek at Sunol Dam.

Gage height in ft.: beginning 2.38, end. 2.38, mean 2.38. Meter No. 6058.

Total area 502.3 sq. ft. Mean Velocity 2.26. Discharge 1138.1.

Dist. From Initial Point	Depth	Depth of observations	Time in Seconds	Revolutions	Revolutions per Second	Velocity per Second	Width	Mean Depth	Area	Discharge of Section	Remarks: On condition of channel, wind, equipment, gage, boat, cable methods, accuracy.
110	0.0										Gage on Sunol Dam = 2.28
115	2.8		32	12	.38	.92			32.9	30.3	
120	5.4										Both the wingmill gage and the 16 ft. bench gages registered 2.28.
125			60	38	.63	1.49	10	6.1	61.	90.9	
130	6.8	Integration									
135			50	49	.98	2.28	10	6.55	66.5	151.6	
140	6.5										
145			49	53	1.08	2.50	10	6.3	65.	157.5	
150	6.1										
155			35	41	1.17	2.70	10	5.9	59.	159.4	
160	5.7										
165			37	47	1.27	2.93	10	5.7	57.	167.0	
170	5.7										
175			30	35	1.17	2.70	10	4.85	48.5	131.	
180	4.0										
185			27	26	.96	2.23	10	3.9	39.	87.0	
190	3.8										
195			45	46	1.02	2.36	10	3.7	37.	87.5	
200	3.6										
205			41	35	.85	1.98			38.4	76.1	
210	3.4										
212	0.0								502.3	1138.1	

Computed by T. W. Espy.

Gauging made June 16, 1922, by C.H. Pratt & C.E., by C.H. Stevens and L.C.Wilson,
on Alamosa Creek at Denil Dam.

Gage height in ft.: beginning 2.05, end 2.05, mean 2.05. Gage No. 0.00.

Total area 208.3 sq. ft. Mean Velocity 2.00. Discharge 1182.1.

Number of observations	Time from	Time to	Gage-height in feet	Time-interval in seconds	Velocity per second	Width in feet	Mean depth in feet	Area of section	Discharge
1	9:30	9:40	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	9:40	9:50	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	9:50	10:00	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	10:00	10:10	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	10:10	10:20	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	10:20	10:30	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	10:30	10:40	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	10:40	10:50	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	10:50	11:00	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	11:00	11:10	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	11:10	11:20	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	11:20	11:30	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	11:30	11:40	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	11:40	11:50	2.05	600	1.98	40.0	5.2	208.3	1182.1
1	11:50	12:00	2.05	600	1.98	40.0	5.2	208.3	1182.1

Gage on Denil Dam = 2.00

Compiled by C. H. Pratt.

Gaging made Jan. 18, 1913, beg. 2:55 P.M. end. 3:30 P.M., by F.C.Herrmann and P.F.Jones,

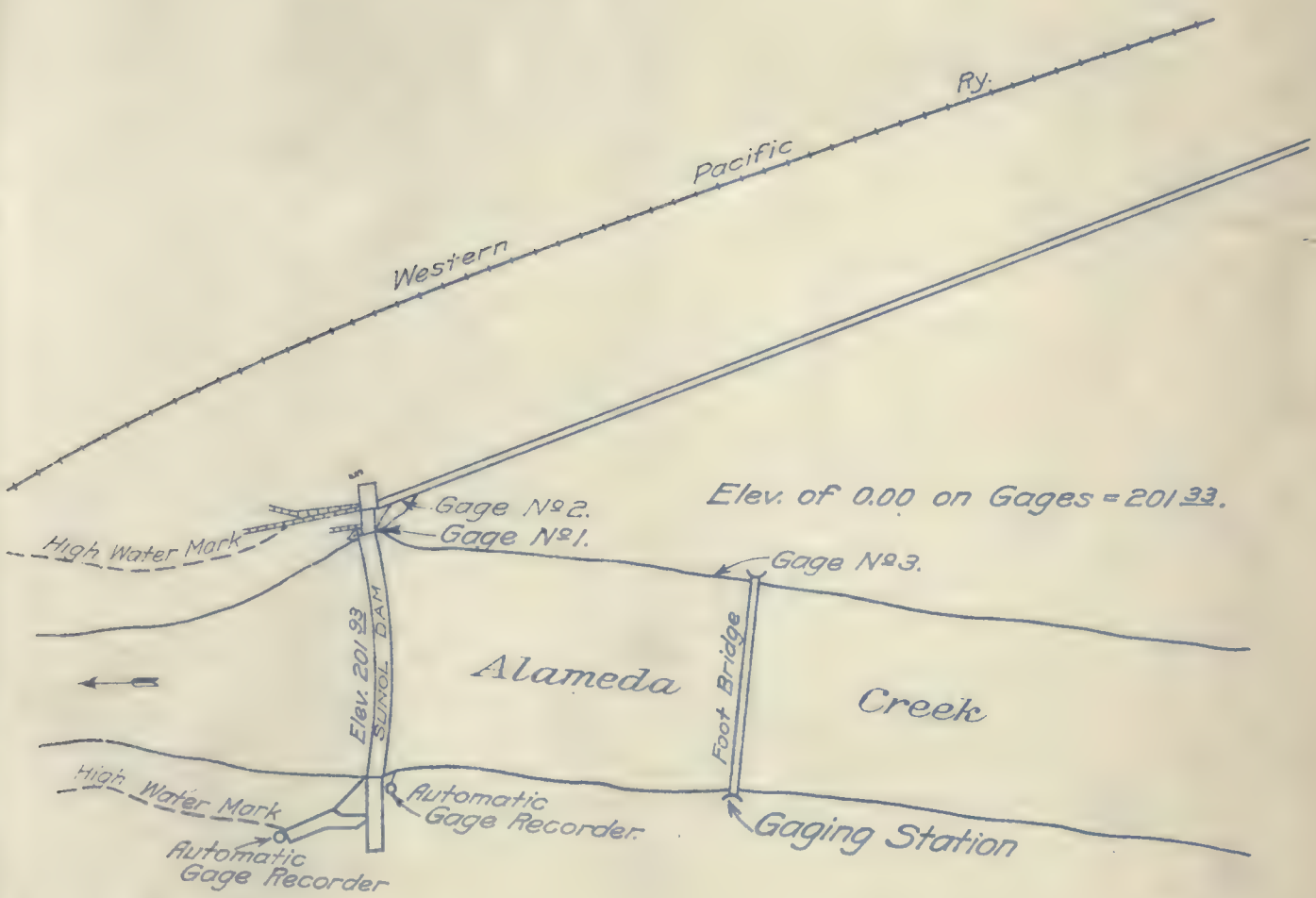
on Alameda Creek at Sunol Dam.

Gage height in ft.: beginning 2.67, end. 2.60, mean 2.63. Meter No. 6158.

Total area 532.1 sq. ft. Mean velocity 2.73. Discharge 1449.8.

Dist. from Initial Point	Depth	Depth of observations	Time in Seconds	Total Number Revolutions	Revolutions per Second	Velocity per Second	Width	Mean Depth	Area	Discharge of Section	Remarks On condition of channel, wind, equipment, gage, boat, cable methods, accuracy.
110	0.0										Gage on Sunol Dam
113	3.1										2.58 Beg.
115		1.8	50	.24½	.49	1.16			35.4	41.1	2.50
120	5.7										2.54
125		3.8	50	.59	.78	1.82	10	6.4	64.	116.5	Int. 33 rev. 42 sec.
130	7.1										
135		4.1	50	.53	1.06	2.45	10	6.95	69.5	170.2	
140	6.8										
145		3.9	50	.61	1.22	2.81	10	6.6	66.	185.5	Int. 49 rev. 40 sec.
150	6.4						10				
155		3.7	50	.71	1.42	3.27	10	6.2	62.	202.8	
160	6.0										
165		3.6	50	.71	1.42	3.27	10	6.0	60.	196.2	Int. 61 rev. 44½ sec.
170	6.0										
175		3.0	50	.72	1.44	3.31	10	5.15	51.5	170.4	
180	4.3										
185		2.5	50	.75	1.50	3.45	10	4.2	42.	144.9	Int. 49 rev. 34½ sec.
190	4.1										
195		2.4	50	.64	1.28	2.95	10	4.0	40.	118.0	
200	3.9										
205		2.1	50	.54	1.08	2.50			41.7	104.2	Int. 29 rev. 28 sec.
210	3.7										
212	0.0								532.1	1449.8	

Computed by T. W. Espy.

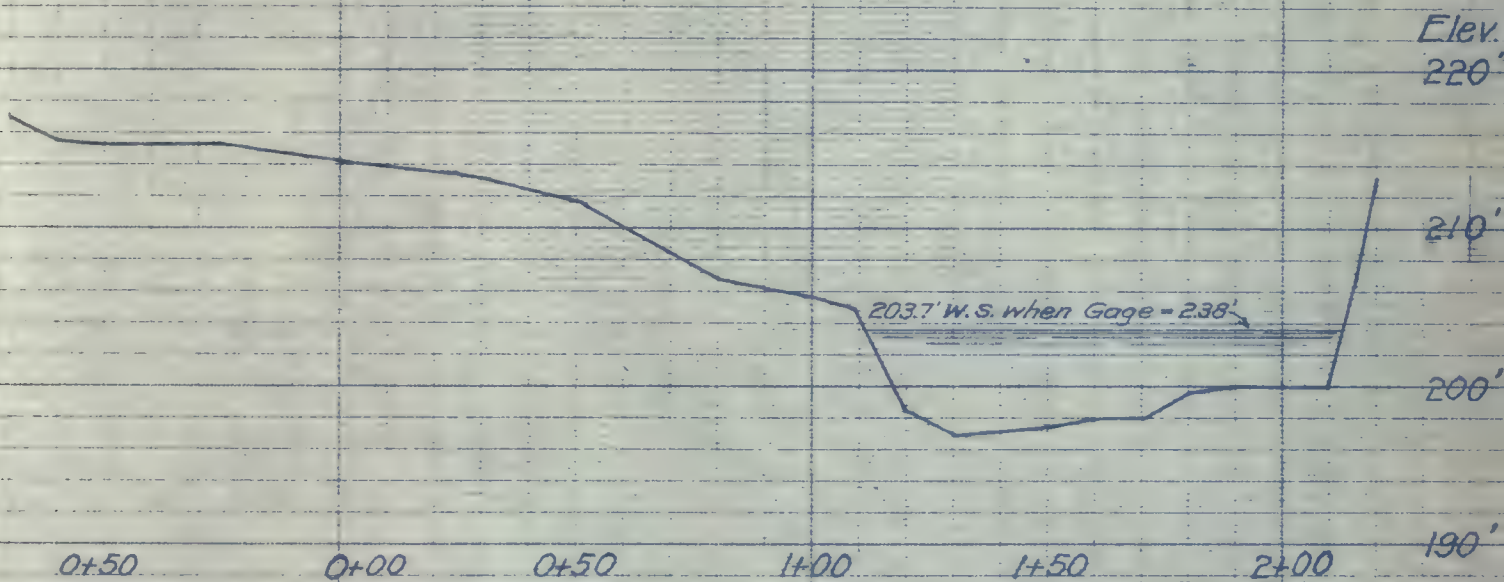


Alameda Creek at Sunol Dam.
Showing Location
of
Gaging Station.

Scale: 1" = 100'

DIAGRAM No 1.

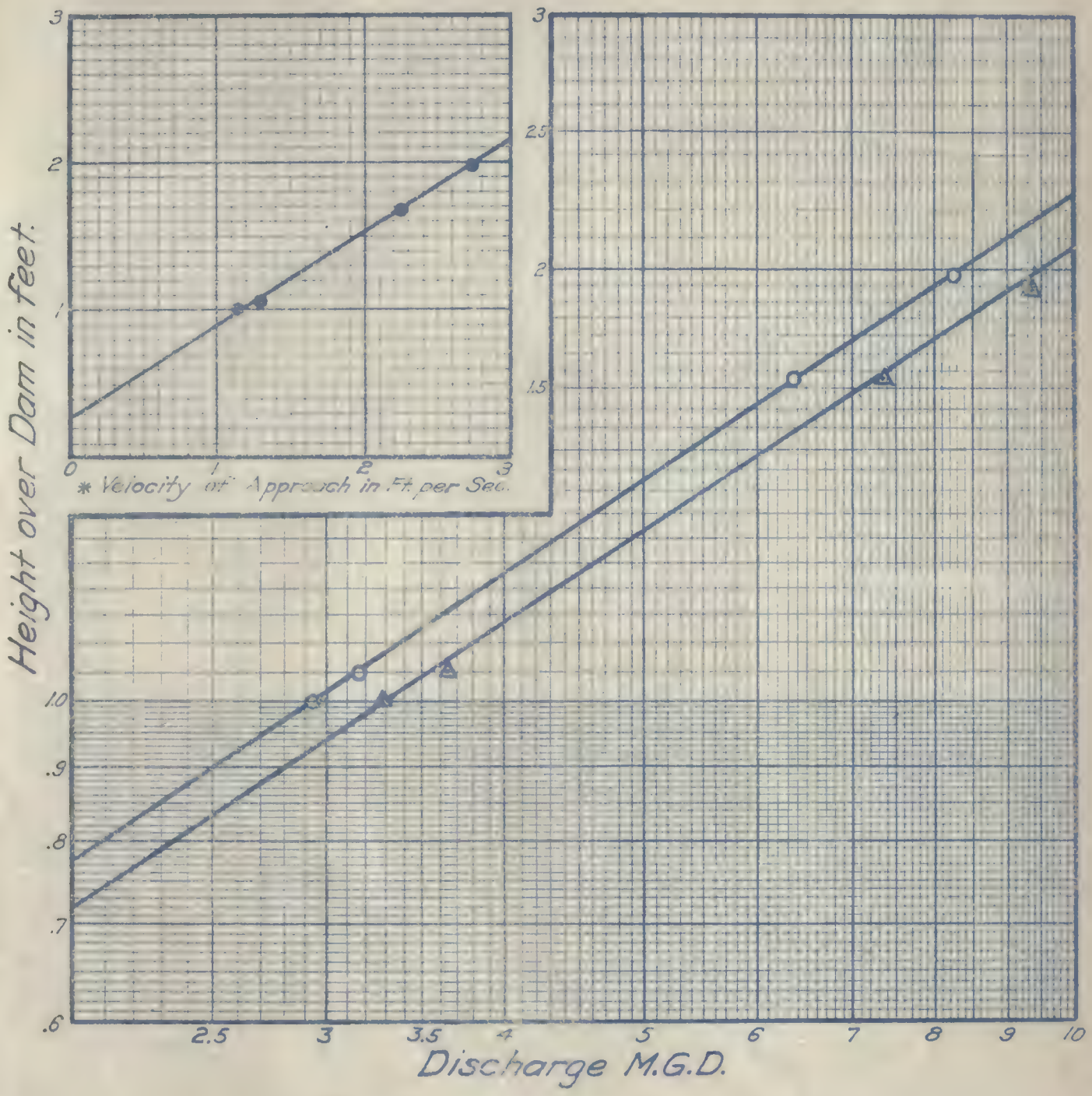
Cross Section of Alameda Creek at Foot Bridge above Sunol Dam.



Elev. 0.00 on Gage = 201.33 Feet.

Elev. of Crest of Sunol Dam. = 201.93 Feet.

DIAGRAM Nº2.



DISCHARGE CURVE
OF
SUNOL DAM.

o Le Conte Discharge.

Δ Measured "

* Velocity of approach measured as the mean stream velocity at gaging station about 200 feet upstream from Sunol Dam.

DIAGRAM Nº 3.